From: Meng, Wuzheng
Sent: Tuesday, April 25, 2006 11:50 AM
To: Raparia, Deepak
Cc: Ritter, John; Alessi, James G
Subject: EBIS Dipole Design Status

Deepak,

I try to summarize the work I have done during the past months. My coordinate system: origin is located at the center of the dipole magnet gap; X is in radial direction (outwards); Y is in vertical (upwards); and Z is in the tangential direction determined by the right hand rule.

(1) Design approach --

Since it is requested to have zero degree enter/exit angles, the only way to get uniform integrated vertical field, is to design a horizontal gradient, that is, the pole faces are sloped, instead of parallel. This can be seen from the figure ebis_dipole_poles.ps. Presently, this (half) angle is about 3.3 degree, or tan-1(0.0576).

The major parameters are:

Bo (central field) = 0.95 T, corresponding to the input current 72288 Ampere-turn per pole. This produces integrated vertical field about 1.6 T-m, bending the Au +32 ion beam by 72.8 degree (required 72.866 degree?).

The minimum gap (at inner most pole edges) is 12.96 cm. If the vacuum chamber width is 6 inch (M. Mape's e-mail 4/4/06), then the minimum vertical space in the chamber region would be 14.09 cm.

(2) Optimization -- I used following iterations in the design:

(a) Modify the pole geometry, get the field (potential) from Opera3d/Tosca;
(b) Track 6 rays starting from Z=0 plane at the center of the magnet. Initial points are (0, 0, 0), (5, 0, 0), (3.5355, 3.5355, 0), (0, 5, 0), (-3.5355, 3.5355, 0), (-5, 0, 0), in cm. These rays represent the ion beam in a R=5cm circle corresponding to central, 0 degree, 45 degree, 90 degree, 135 degree, and 180 degree;

(c) Compute the field and integral along these 6 trajectories; estimate the errors; go back to (a).

In the attachments, file "int_by_fld_d9_s8_l.xls" shows the integrated B_y component along 6 rays, and at the bottom of the file, uniformity is estimated as 8E-4. File "ebis_d9_s8_har.xls" shows the harmonics analysis. There is about -3.56 % quadrupole implies the horizontal defocusing effect (vertical focusing). Other mutipoles are all very small (E-4 to E-5).

(3) Other issues --

Due to the lack of steel volume in the smallest radius region, the back leg steel saturation level has been checked. In the present design, the jpeak field on the surface of the back leg steel is around 1.9 T inside steel; less than 240 Gauss in the air next to it.

The fringe field cast by the dipole on to the Booster orbit (d/s C2 section), is estimated around 23 Gauss (maximum).

Please comment. Wuzheng Meng